PATENT

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GROUP 3600

In re Application of:	)	
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Masatoshi FUJIMOTO et al.	)	**BOX AF**
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Application No.: 10/076,273	)	Group Art Unit: 3641
	)	
Filed: February 19, 2002	)	Examiner: J. Richardson
	)	
For: RADIOISOTOPE GENERATING	)	
APPARATUS	)	

Commissioner for Patents
Arlington, VA 22202

Sir:

DECLARATION UNDER 37 C.F.R. § 1.132

I, Professor Kenji OKUNO, do hereby make the following declaration:

1.   I have been employed by the Shizuoka University in Shizuoka, Japan since 1997 and presently have the title of Professor. Radiochemistry, including research of the chemical behavior of radioisotopes, encompasses a major portion of my technical area of concentration. Such research is typically applied to nuclear fusion applications. Examples of my particular research subjects and selected recent publications are listed in the attached Appendix A.

2.   I received a Doctor of Science from Tohoku University.

3.   I have read the above-identified 10/076,273 application file, including (a) the specification, drawings and claims, (b) the Office Action dated August 13, 2002, (c) the Final Office Action dated March 7, 2003, the applied references to (d) Whittlesey (U.S. Patent No. 3,378,446) (hereinafter "Whittlesey") and (e) Hedstrom (U.S. Patent No. 3,762,992) (hereinafter "Hedstrom"), and (f) the Response and Request for Reconsideration filed on February 13, 2003.

4. I have read the attached document ("D1") authored by G. Pretzler et al., Phys. Rev. E, Vol. 58, p. 1165 (1998). The D1 document teaches that neutrons released from d (d,n) ^{3}He fusion reactions have been observed in the focus of laser pulses on a deuterated polyethylene target (bulk solid-state target). The D1 document teaches that its arrangement results in about 140 neutrons per laser shot being obtained with a laser intensity at a focal point of the order of 10^{18} W/cm^2.

5. I have read the attached document ("D2") authored by T. Ditmire et al., Nature, Vol. 398, p. 489 (1999). The D2 document reports the observation of nuclear fusion from the explosions of deuterium clusters heated with laser pulses. In this experiment, large. deuterium clusters are produced in the expansion of a deuterium gas jet into a vacuum. A high-intensity laser pulse is focused into the gas of deuterium clusters, and as a result, about 1 x 10^4 neutrons per laser shot are obtained with a laser intensity at a focal point of about 2 x 10^{16} W/cm^2. The D2 document does not discuss the generation of an isotope.

6. By comparing these experiments discussed in items 4 and 5 above, I conclude that the cluster-state target has a significant advantage over the bulk solid-state target. Specifically, regarding the laser intensity, the intensity discussed in D2 is about 100 times smaller than that in D1. Further, regarding the neutron production efficiency, the efficiency in D2 is about 100 times larger than that in D1, even at the lower laser intensity.

7. I have read the attached document ("D3") authored by I. Spencer et al., Nucl. Instr. and Meth. in Phys. Res. B, Vol. 183, p. 449 (2001). The D3 document teaches that when a laser pulse with an intensity of about 5 x 10^{19} W/cm^2 is focused onto a thin aluminum target, protons accelerated and emitted from the aluminum target become incident on a bulk SiO$_2$ target and, as a result, an ^{13}N component is produced via an ^{16}O(p, α) ^{13}N reaction.

8. By using the laser described in the specification of the 10/076,273 application, as asserted in section (3) at page 5 of the Response and Request for Reconsideration filed on February 13, 2003, a laser intensity of 10^{18} to 10^{19} W/cm^2 can be achieved by improving the focusing efficiency by use of a wavefront compensation, or similar techniques that are known in the art.

9. The specification of the 10/076,273 application discusses an example of a nuclear reaction for generating a radioisotope in which water molecule clusters are used as the nuclear reaction target. I am not aware of any previous disclosure of such an arrangement. The water clusters contain ^{16}O and p, and therefore I understand that such clusters can be used as the target value for the ^{16}O(p, α) ^{13}N reaction. The possibility of realizing an ^{16}O(p, α) ^{13}N reaction by using a laser is evidenced by the teachings of the D3 document described in item 7 above.

10.   The particles used in the reaction must have a certain value of energy to make the reaction cross section sufficiently large. For this problem, the D3 document discloses the fact that the protons (particles) are accelerated to the sufficient energy with the large reaction cross section value (see Fig. 4 of D3, for example). The Q-value and the reaction cross-section for the $^{16}O(p, \alpha)$ ^{13}N reaction are summarized respectively in Table 1 and Fig. 3 in D3. Note that the quantity Q listed in Table 1 is the threshold value for the reaction.

11.   In the nuclear reaction of the example described in the specification of the 10/076,273 application, water molecule clusters are used as the target material. The Applicants' discovery of the use of water as a target source material has great utility at least in that it results in a relatively simple reaction and post-reaction process.

12.   In the nuclear reaction of the example described in the specification of the 10/076,273 application, the laser intensity is only about 10 times smaller than that discussed in the D3 document, even under normal focusing conditions. Therefore, because of the above-mentioned great advantage of the cluster-state target, it is clear that the $^{16}O(p, \alpha)$ ^{13}N reactions occur with high efficiency in the example described in the specification of the 10/076,273 application. Moreover, when the focusing efficiency is improved by wavefront compensation or by other known methods, performance increases even further.

13.   At page 3, lines 13-22 of the Final Office Action, the Examiner alleges that Applicants are "attempting to **add** information that was not in the original disclosure, for example, **in order to effectively cause the reaction to occur, the intensity of the laser should be increased by narrowing the laser beam to as small a spot size as possible.**" I declare that descriptions of such laser beam convergence are supplied throughout the specification, as originally filed, at least at page 9, lines 3-24 and page 30, lines 5-24, for example.

14.   At page 4, lines 8-18 of the Final Office Action, the Examiner alleges that "in citing these sections of the original specification, the applicant has attempted to introduce new matter relating laser details, such as a) pulse width of 7.0TW at an instantaneous maximum output, b) spot size of laser narrowed to about 10 microns at a converging point, c) intensity of the laser at the converging point reaches 10 power 18 to 10 power 19 Watts/cm2." I declare that one having ordinary skill in the art could easily arrive at the maximum output of about 7 TW in light of the pulse energy value of 200 mJ and the pulse width of 30 fs, which are disclosed in the specification as originally filed at page 8, lines 9-10. Moreover, a laser spot size of about 10 um is a common value understood to those skilled in the art in an arrangement in which the subject laser beam is used in the

converged state, as discussed in the specification. By knowing this spot size, I declare that one having ordinary skill in the this art would easily determine that the laser intensity at a focal point is within a range of 10^{18} to 10^{19} W/cm^2.

15. It is well known by those having skill in the subject art that certain nuclear species, for example, a range of particles such as alpha's, neutrons, and photons, are generated when a nuclear reaction occurs. Moreover, those having skill in the subject art would understand that such nuclear species would be produced by the nuclear reactions described at pages 33-34 of the specification of the 10/076,273 application and that these nuclear species can be utilized as positron sources. Further, it is well known that the alpha particles or neutrons generated with these reactions can be used for monitoring the nuclear reactions. Any of a number of detection methods, that are well known in the field of nuclear physics, can be used for detecting these particles.

16. The synchronization of the spraying timing of the source material with the arrival timing of the output light at the nucleus generating region is described in the specification of the 10/076,273 application and is a concept that is understood to those having skill in the subject art. One example of such a synchronization method involves the introduction of material before laser irradiation by synchronizing the introduction of the material with one prior pulse of laser. Synchronization using such a methodology is well known to those having skill in the subject art, and therefore I believe that the specification's description is sufficient to enable one having ordinary skill in the art to utilize such a methodology in connection with the Applicants' invention. These synchronization methods are commonly used techniques in the subject art, a number of which may be used in connection with the subject invention.

17. From my background and experience in the field of nuclear reactions, I understand the necessity of making a Positron Emission Tomography (PET) system small. Moreover, I have paid attention to the use of a small-sized laser in a deuterium-deuterium (D-D) reaction, and especially to the use of this technique for a small-sized neutron source. As a result, I believe that the techniques disclosed in the present application are new and useful. I also believe that the disclosed techniques result in significant advantages over prior arrangements in the field of nuclear reactions.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: _Dec./11/'03_____   By: _____

Professor Kenji OKUNO